visitors to *B. n. nanum* flowers (Thorp 1969, 1990), they may have the potential to strongly influence pollen flow within *B. n. nanum* patches.

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Scientific Note

LONG-TERM CHANGES IN *OBSCURA* GROUP *DROSOPHILA* SPECIES COMPOSITION AT MATHER, CALIFORNIA[1]

Since the 1940s, Dobzhansky and his collaborators have collected *obscura* group *Drosophila* species from Mather, California, located at 1375 m on the western slope of the Sierra Nevada. Mather's Transition Zone association and moderate climate have made it one of the most heavily-collected areas in the world for *Drosophila*. Fifty years of accumulated data give us the rare opportunity to study long-term changes in *Drosophila* species' relative abundances. Such studies can also identify effects of climatic changes on species frequencies. This study documents evolution in *obscura* group *Drosophila* species composition at Mather, shows that the changes are associated with climate, and provides a baseline for future investigations.

The genetics of the *D. obscura* group have been studied extensively, but their ecology is largely unknown. The ranges of the four native California species vary latitudinally and altitudinally. In zones of geographic overlap, *Drosophila pseudoobscura* Frolova and *D. azteca* Sturtevant & Dobzhansky are more frequent in warmer and drier areas and at lower altitudes (Dobzhansky, T. & J. Powell. 1975. pp. 537–587. *In* R. King (ed.). Invertebrates of genetic interest. Plenum Press, New York.). *Drosophila persimilis* Dobzhansky & Epling and *D. miranda* Dobzhansky predominate at higher elevations and northern latitudes. Based on their zoogeography, *D. azteca* and *D. pseudoobscura* are perceived as the more dry/hot adapted of the four species.

Dobzhansky (1973. Evolution, 27: 565–575) noted an increase in the frequency of *D. persimilis* relative to *D. pseudoobscura* at Mather. Figure 1A shows this trend, supplemented with data from later collections by the persons mentioned in the acknowledgment. However, such relative abundances can be deceptive when the rest of the species group is ignored. Figure 1B shows the frequencies of

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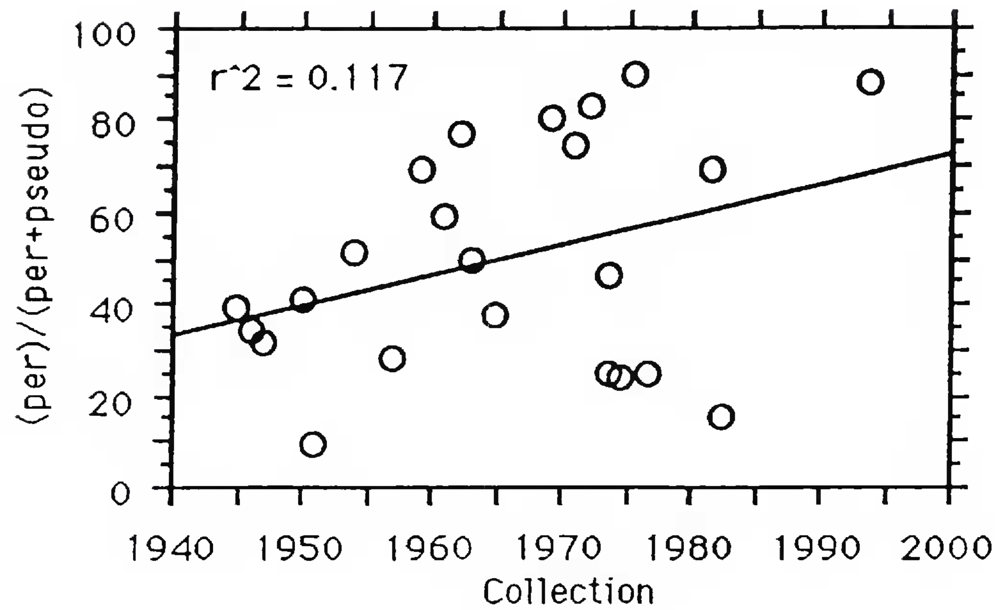
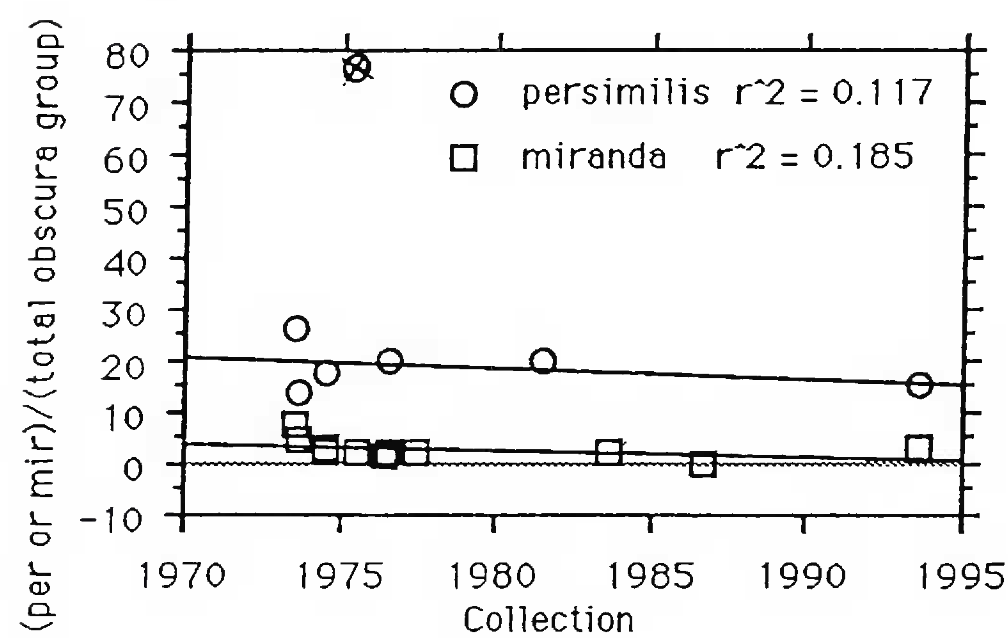
A.


r^2 = 0.117
(per)/(per+pseudo)
100
80
60
40
20
0
1940
1950
1960
1970
1980
1990
2000
Collection

B.


persimilis r^2 = 0.117
miranda r^2 = 0.185
(per or mir)/(total obscura group)
80
70
60
50
40
30
20
10
0
-10
1970
1975
1980
1985
1990
1995
Collection

C.

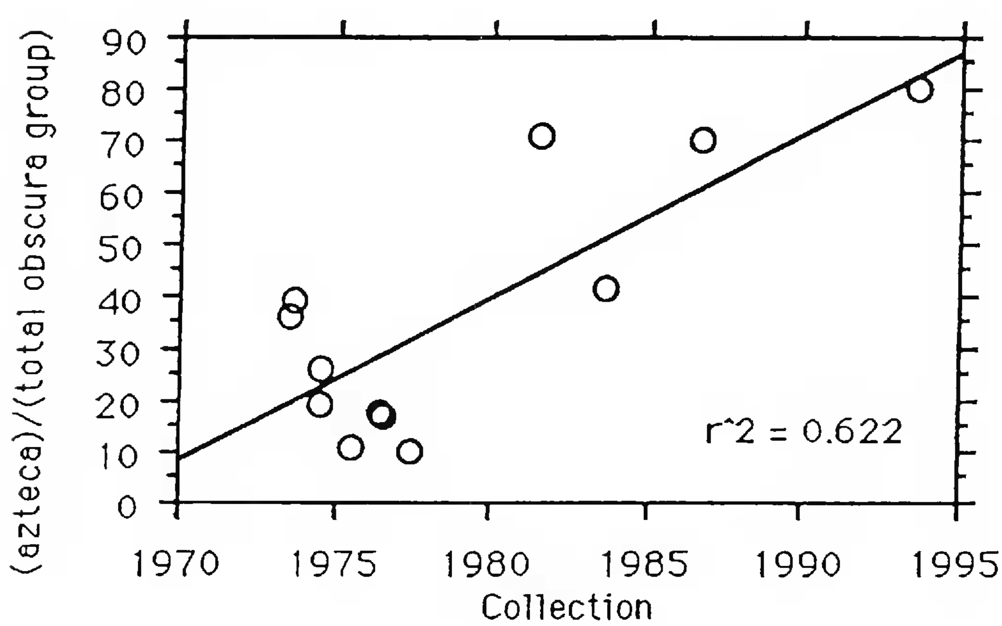

r^2 = 0.622
(azteca)/(total obscura group)
90
80
70
60
50
40
30
20
10
0
1970
1975
1980
1985
1990
1995
Collection

Table 1. Multiple regression equation of arcsine transformed species frequency with cm rainfall and year: month collection (e.g., June 1974 = 74.5).

Species	Intercept	Rainfall	Year: month	r^2	n	P
D. pseudoobscura	−13.56	−0.91	0.20	0.85	7	0.021
D. azteca	−4.60	−0.05	0.08	0.68	12	0.006

D. persimilis and *D. miranda* relative to the frequencies of all *obscura* group species for the last twenty years of collections. Except for one anomalous year, their relative frequencies remained constant. However, *D. azteca* increased in frequency dramatically (see Fig. 1C), and *D. pseudoobscura*'s frequency dropped from 54% in 1974 to 2% in 1993.

Temperature data for Mather are not available, but I obtained rainfall measures for the 1973–1993 period from the National Climatic Data Center. Multiple regressions of *D. pseudoobscura* and *D. azteca* frequencies on collection date and cm rainfall for the preceding month were significant (see Table 1). The frequencies of both species regressed positive to collection date and negative to rainfall, but the different coefficient magnitudes caused the opposite trends observed. The negative regressions to rainfall corroborate the claim that these species prefer drier environments.

Although rainfall partially explains these species' relative frequencies, the association with collection date suggests an unknown secular trend. The simplest explanation is that *D. azteca* is replacing *D. pseudoobscura,* but there are many alternative hypotheses. Is there something gradually accumulating or being depleted in the environment causing the changes in frequencies? Do these changes reflect differences in the intrinsic potential for these species to increase in numbers? Many questions remain unanswered.

The processes occurring at Mather can be better understood with density studies. Without an estimate of the number of flies present each year, we cannot say whether any species are increasing or declining in absolute abundance. Absolute numbers available for previous collections at Mather are unrevealing due to different collecting methods. Further, previous studies at Mather have shown that the densities of these species vary considerably, even at the same time of year over different years (Taylor, C. & J. Powell. 1983. pp. 29–59. *In* Ashburner, M., H. Carson & J. Thompson (eds.). The genetics and biology of *Drosophila* (Vol. 3). Academic Press, New York). Future studies should combine relative species abundances with density measurements to ascertain how the observed relative trends relate to changes in population sizes.

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Figure 1. Relative frequencies of *Drosophila* species collected at Mather. (A) shows the percentage of *D. persimilis* flies relative to the total number of *D. pseudoobscura* plus *D. persimilis* flies caught. (B) shows the percentage of *D. persimilis* and *D. miranda* flies relative to the total number of *obscura* group flies captured. (C) shows the percentage of *D. azteca* flies relative to the total number of *obscura* group flies collected.

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New Journal Submission Address, New Laboratory Building: Plant Pest Diagnostics Center

Effective 1 Jan 1995, the following address change should be noted for all new submissions to *The Pan-Pacific Entomologist:*

Dr. John T. Sorensen
Editor - Pan-Pacific Entomologist
California Dept. of Food & Agriculture,
Plant Pest Diagnostic Center,
3294 Meadowview Road,
Sacramento, California 95832-1448

All correspondence to the PCES Treasurer or Secretary, including all financial inquires, should continue to be addressed to their California Academy of Sciences addresses. Correspondence directed to the Associate Editor, Dr. Robert V. Dowell, should be addressed to him at: CDFA, Pest Detection/Emergency Projects, 1220 "N" Street, Sacramento, CA 95814.

This address change is caused by the movement of CDFA's Insect Taxonomy Laboratory to a newly constructed biology laboratory building, the Plant Pest Diagnostics Center (PPDC). The new facility is in southern Sacramento at the CDFA meadowview operations complex, which it shares with the department's Chemistry Laboratories, greenhouses and facilities for emergency projects and biological control.

The new 53,000 sq ft PPDC building houses separate laboratories for Insect Biosystematics, Botany, Seeds, Plant Pathology and Nematology. The Insect Biosystematics section has a 1.5 million specimen, compactor-based insect collection, a nucleotide laboratory and a critical point drying facility. Additionally, all PPDC laboratories share a photographic darkroom, scanning and transmission electron microscope facilities and a 25,000 volume, compactor-based library. The PPDC has a staff of 46, including 22 scientists. Its insect biosystematists are: Fred Andrews, Karen Corwin, Tom Eichlin, Eric Fisher, Ray Gill, Alan Hardy, Terry Seeno, Ron Somerby, and John Sorensen.